RAW MATERIALS

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USE OF MATERIAL FROM THE KURSK MAGNETIC ANOMALY REGION IN THE PRODUCTION OF MEDICAL CONTAINERS

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The possibility of using natural and technogenic materials from the Kursk Magnetic Anomaly region, namely, quartzite-sandstones for introducing silicon oxide in the production of medical containers, as well as using electric filter dust from the Oskol'skii Electrometallurgical Works as a nontraditional pigment for brown pharmaceutical containers are investigated. The properties of experimental glasses based on quartzite-sandstones are not inferior to industrial glasses and meet the requirements imposed on medical containers. The advisability of tinting glass mixture in the feeder channel using electric filter dust is demonstrated.

Expansion of the list of available materials for the glass industry by developing new deposits, including local-scale deposits, upgrading methods for concentration of quartz materials, and involving available raw materials and recycled materials from other industrial sectors, have become timely topics. The Central Chernozemie region with its extended infrastructure experiences constant shortage of glass needed for construction, containers, and other purposes. This is due, on the one hand, to the absence of glass factories in the region, and on the other hand, to the presence of a great number of companies consuming glass and glass products. It is expedient to develop glass production in Central Russia by creating new glass-melting facilities in the region, for instance, setting up sheet glass production in the Orel and Belgorod regions, and container (bottle, jar, and pharmaceutical) glass in the Tambov, Kursk, Belgorod, and Voronezh regions. One should take into account the presence of silica-bearing materials in these regions.

Research carried out by the Belgorodgeologiya Company established the possibility of obtaining materials on the territory of Belgorod region. The basic materials may be crystalline shale, quartz sand of the paleogenic system classified as glass sand, chalk, and marl from iron ore deposits at the Kursk Magnetic Anomaly (KMA). The quartz sands of the Buchakskoe suite and Poltava paleogenic series in their natural form largely meet the requirements of GOST 22551–77 for grades T and PS-250 and after concentration using the flotation method they satisfy the requirements for grades S-070-2, OVS-025-1, and B-100-1 and are suitable for producing glass and bottles. Glasses have been produced on the basis of artificial sand from quartzite-sandstones [1, 2], which can be used for production of amber-color and dark green bottles, tinted architectural and building glasses, and black mablite-type glasses. Furthermore, quartzite-sandstone is interesting as a pigment, since it contains up to 1.58% iron, which imparts sky-blue, yellow-green, and brown shades to glasses.

Crystalline shale, chalk and marl from iron-ore deposits can be used as the alumina, carbonate, and alkaline batches in glass production [3].

Graphite and pegmatites as well can be used in glass production; however, their deposits are characterized by complicated mining conditions and they are currently of no commercial value, since they are located at a depth of 200 – 300 m. Additional geological survey is needed for final evaluation of the quality of material and determination of available resources.

A main requirement imposed on medical glass is high chemical resistance to reactants. This determines the specifics of glass composition [4]. Numerous chemical analyses indicated that sands deposited in the Belgorod region and quartz-bearing byproduct rocks do not contain toxic compounds, which would be inadmissible in medical glass compositions. Consequently, the possibility of using such sands in the production of clear and brown medical containers was additionally investigated.

In determining chemical resistance of medical glasses, they are tested for water, acid, and alkali resistance. Chemi-

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TABLE 1

Initial material	Mass content, %*									
	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	P_2O_5
Quartzite-sandstone:										
semi-weathered	96.46	0.01	1.10	0.26	0.61	0.04	0.32	0.05	0.07	0.26
fresh massive	94,54	0.04	1.35	0	1.58	0.57	0.51	0.20	0.15	0.10

* MnO content in both cases amounted to 0.01%.

cal resistance in industrial conditions is controlled based on pH variations in the solution filling the product under specific conditions [5]. Water resistance of industrial glasses should have at least hydrolytic class III. Thermal properties of medical glasses are the same as those of standard container glasses or slightly better: TCLE is equal to $(70 – 87.5) \times 10^{-7}\ K^{-1}$, and heat resistance 125 – 160°C [6].

Production of glass for medical purposes currently includes ten grades of glass, whose compositions and physicochemical properties are regulated by respective standards (OST 64-2-78–78, GOST 19809–85, and GOST 19808–86 with amendments dd. 28.05.98). Although most medical glass compositions have been industrially used for more than 20 years, published data on their technological properties are scarce.

The current aim of the medical glass sector is to replace borosilicate glass by alkali-lime-glass, which would make its possible not only to save expensive boron-bearing materials, but also to save fuel, initial materials, and refractories, due to an increased output of fit products and reduced melting temperature.

The purpose of our study was to study the possibility of using natural materials and byproducts mined in the Kursk Magnetic Anomaly (KMA) region in the production of clear and brown pharmaceutical containers of grade MT. Silicon oxide was introduced via quartzite-sandstone, and the pigment for tinting glass melt was a nontraditional one: electric filter dust from the Oskol'skii Electrometallurgical Works. Such glass should have sufficiently good water resistance and high light transmission in the visible spectrum range; besides, brown container glass should shield from thermal rays. The chemical compositions of quartzite-sandstones of different genesis are listed in Table 1. They have a sufficiently constant chemical composition and do not contain oxides of heavy metals (lead, zinc, antimony, arsenic). The content of colorant oxides (iron, titanium, manganese) is rather high (up to 0.88%), but they are contained mostly in the form of paste impurities or ore inclusions, i.e., are free impurities removable by traditional methods for quartz sand concentration, (magnetic separation, washing, attrition, etc.).

The main quartz-bearing material used in the studies was semi-weathered quartzite-sandstone, which can be regarded as glass sand according to its content of the main component (at least 95% according to GOST 22551–77). An obligatory preliminary stage in preparing quartzite-sandstone is consecutive double crushing of lumps in serial jaw crushers ShDS-1-2.5×9 and ShDS-II-1.6×2.5. Under laboratory conditions, a mechanical attrition set was used to remove free impurities and iron oxide film and separate sand dust.

The results of classification of materials after the second crushing (sieves Nos. 08 – 01) before and after mechanical attrition demonstrated that the granular composition of nonconcentrated quartzite-sandstone contains over 34% dustlike fraction and 65% glass fraction (0.8 – 0.1 mm). The high content of the fine fraction is due to the formation conditions of this siliceous materials: the effect of winds and atmospheric precipitation. The glass fraction content is sufficiently high and mechanical attrition can increase it to 70% and reduce the dust fraction content to 29%. Simple sifting through a set of sieves can remove dust from the siliceous material and improve its granulometric composition. It is known that colorant iron oxides owing to their higher density and smaller grain size are, as a rule, concentrated in finely dispersed sand fractions. Therefore, screening of the dustlike fraction allows for simultaneous removal of the major part of colorant oxides, which contributes to better light transmission of glass in the visible range.

Batch preparation was performed by the standard methods; SiO_2 was introduced via concentrated and nonconcentrated quartzite-sandstone (100 wt.%). Six glass compositions were melted, which differed in their initial materials and in melting conditions. Furthermore, the possibility of tinting glass melt in the feeder channel by a nontraditional pigment based on electric filter dust was investigated. According to the x-ray phase analysis data, the basic dust composition is represented by magnetite Fe_3O_4. The elemental composition was studied with a spectrophotometer. It was found that the intensity of the peak attributed to iron was around 95%, whereas the content of other colorant elements (Cr, Cu, Ni, Co) was a hundredth or a thousandth of 1percent. The initial pigment in the form of a finely dispersed fraction was briquetted in tablets of size 5 × 5 × 3 mm and introduced in the glass melt at the stage of clarification and homogenization in an amount of 1.5% (above 100%).

The glasses obtained were well melted and clarified. The pigment was totally dissolved, and in order to create the mixing effect in the laboratory conditions and ensure a uniformly tinted glass melt, a wet wood piece was placed in the crucible.

TABLE 2

Parameter	Glass based on quartzite-sandstone		Brown glass tinted in feeder
	noncon-centrated	concentrated	
Total light transmission, %	82.5	86.4	32.0
Density, kg/m^3	2480	2475	2485

* Water resistance of glasses in all cases has hydrolytic class III.

Annealed glasses were analyzed for total light transmission using a POS-1 instrument, water resistance of glasses was measured according to the powder method developed at the State Institute of Glass (GIS), and glass density was determined by hydrostatic weighing. The experimental results are shown in Table 2.

Experiential glasses based on quartzite-sandstone are not inferior to industrial glasses in water resistance and satisfy the requirements of GOST 10782–85. The protective properties of brown glasses as well meet the requirements imposed on heat-shielding properties.

Thus, semi-weathered quartzite-sandstone from KMA can be used to produce semiwhite container for medical purposes. The content of the main material and the granulometric composition of quartzite-sandstone concentrated by mechanical attrition satisfy the requirements of GOST 22551–77 imposed on silica materials for glass.

By modifying the redox melting conditions and introducing a required pigment, it is possible to obtain brown pharmaceutical containers.

Tinting glass in the feeder channel using the nontraditional colorant (electric filter dust) makes it possible to produce glasses with different spectral characteristics in the same furnace.

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